ESCAPE ONLY RESPIRATORS FOR PROTECTION AGAINST CBRN AGENTS

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TOPICS COVERED

- Brief History of NIOSH CBRN Agent Approved Respirators
- Types of NIOSH CBRN Agent Approved Escape Only Respirators
- Pentagon Escape Only Respirator
- New Military Escape Mask - Joint Service Chemical Environment Survivability Mask (JSCESM)

Since 9/11 America has been in a war against terrorism.

Presidential Directive 62 “Combating Terrorism”

May 1998

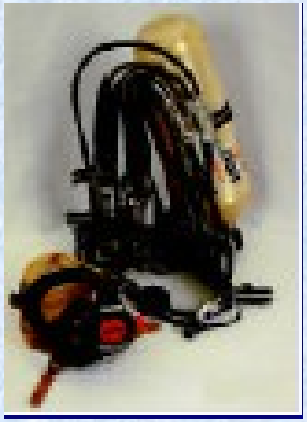
Created a systematic approach to fight terrorism in the 21st century.

In response, municipal, state and national guard responder groups started developing plans to respond to chemical, biological, and radiological (CBR) terrorism.

> However, there were no respirators approved by NIOSH as protection against CBR agents.

This eventually lead to establishment of a interagency agreement between NIOSH, US Army Research, Development and Engineering Command (RDECOM), and National Institute of Standards Technology (NIST) to jointly develop methods for certifying respirators

NIOSH CBRN AGENT APPROVED RESPIRATOR SCHEDULES TIMETABLE



SCBA December 2001

Gas Mask March 2003

Escape Only October 2003

PAPR March 2004

Closed Circuit Escape Only 2005

CBRN Air-Purifying Escape Respirators and CBRN Self-Contained Escape Respirators

NIOSH began accepting applications on November 6, 2003, to test and evaluate air-purifying escape respirators for use against CBRN agents and on January 2, 2004, to test and evaluate s
escape respirators for use against CBR

These respirators will be approved for protection of the general working population during escaping from terrorist events involving possible CBRN agents.

Three Categories

Air-purifying “General Category”

Air-purifying “Specific Category”

Design Considerations for CBRN Air-Purifying Escape Respirators

The respiratory inlet covering for respirators approved for escape from terrorist events will be hooded, protecting the wearer's entire head, eyes, and respiratory system.

Hood will include an area for field of vision and be compatible with wearing prescription glasses.

The respiratory system is connected to filtered air by either the hood itself or inside the hood by nose cup or mouthpiece with nose clips.

Once fully donned, wearing the respirator shall not

General Category Air Purifying Escape Respirators

Approved for escape from low concentrations of chemical warfare agents and toxic industrial materials.

Not for use in atmospheres containing less than 19.5% oxygen.

Service Life Duration Rating

Escape respirators will be rated for 15, 30, 45, or 60-minute duration as specified by the manufacturer.

Respirators are tested at *64 liters per minute*.

Respirators will also provide a minimum "**Panic Demand**" criteria in which they must have a service life of at least five minutes at a breathing rate of *100 liters per minute*.

AIR-PURIFYING ESCAPE ONLY RESPIRATORS CHEMICAL AGENT PENETRATION AND PERMEATION TESTING AT RDECOM

Simulated breathing is performed through the respirator on the Simulant Agent Resistant Test Manikin (SMARTMAN) in an enclosed air-tight exposure chamber.

210 mg/m^3 Sarin (GB) vapor challenge for either 30, 60, 90, or 120 minutes,

50 mg/m^3 Distilled Sulfur Mustard (HD) vapor for either 30, 60, 90, or 120 minutes,

0.43 to 0.86 milliliters liquid HD

MUSTARD AGENT

Named after its characteristic odor.

Mustard gas was used during WWI to blister the skin, eyes, and lungs.

The term “The Blind Leading the Blind” comes from evacuation of soldiers blinded by mustard gas.

Sarin

$C_4H_{10}FO_2P$

Nerve gas was manufactured but not used during WWII.

Tabun was the first nerve agent, which was discovered on 23 December 1936 by the German Dr. Gehard Schrader, who was developing new types of insecticides.

In 1938, Sarin, the second organophosphate nerve agent was developed and named for its four discoverers: ***S***chrader, ***A***mbros, ***R***udriger, and van der L***in***de.

* 26 times more deadly than cyanide gas
* a pinprick size droplet can kill an adult human.

Blocks formation of acetyl-cholinesterase, the chemical that acts as the body's "off switch" for glands and muscles. Without the "off switch," glands and muscles

AIR-PURIFYING ESCAPE ONLY RESPIRATORS

CARTRIDGE TESTING

NIOSH and RDECOM identified 139 potential respiratory hazards during terrorist attack.

NIOSH grouped chemical hazards into families of chemicals, and has researched representative chemicals in each family to test the cartridges during the respirator certification process.

ORGANIC VAPOR FAMILY

Cyclohexane was selected to represent the family of 61 organic vapors.

acetone cyanohydrin
acrylonitrile
allyl alcohol
allyl chlorocarbonate
bromoacetone
bromobenzylcyanide
chloroacetone
chloroacetonitrile
chloroacetophenone
chloroacetyl chloride
Chloropicrin
chloropivaloyl chloride
crotonaldehyde
cyclohexyl methyphosphonate
dibenz-(b,f)-1,4-oxazepine
Diketene
dimethyl sulfate
diphenylchloroarsine
ethyl chloroformate
ethyl chlorothioformate
ethyl phosphorodichloridate
ethylene dibromide
hexachlorocyclopentadiene
hexaethyl tetraphosphate
iso-butyl chloroformate
iso-propyl chloroformate
lewistite
methanesulfonyl chloride
methyl orthosilicate
methyl parathion
mustard, lewisite mixture
nitrogen mustard HN-1
nitrogen mustard HN-2
nitrogen mustard HN-3
n-propyl chloroformate
o-chlorobenzylidene
phenyl mercapatan
phenylcarbylamine chloride
phenyldichloroarsine
oximedichloroforoxime
phosgene
sarin
sec-butyl chloroformate
soman
tabun
tert-octyl mercapatan
tetraethyl dithiopyrophosphate
tetraethyl lead
tetramethyl lead
tetranitromethane
trimethoxysilane
trimethylacetyl chloride
VX
diphosgene
o-ethyl-s-

Acid Gas Family

Cyanogen chloride, phosgene, hydrogen cyanide, hydrogen sulfide, and sulfur dioxide are the representative test agents for the 32 acid gases.

boron tribromide
boron trichloride
boron trifluoride
bromine
bromine chloride
bromine trifluoride
carbonyl fluoride
chlorine
chlorine pentafluoride
chlorine trifluoride
chlorosulfonic acid
cyanogen chloride
dichlorosilane
ethyl phosphonous dichloride
fluorine
hydrogen bromide
hydrogen chloride
hydrogen cyanide
hydrogen fluoride
hydrogen iodide
hydrogen sulfide
hydrogen selenide*
phosgene
phosphorus trichloride
silicon tetrafluoride
sulfur dioxide
sulfur trioxide
sulfuric acid
sulfuryl chloride
titanium tetrachloride
tungsten hexafluoride
bromine pentafluoride*

Nitrogen Oxide Family

Representative Test Agent = nitrogen dioxide

nitric acid fuming nitric acid nitrogen dioxide nitrogen tetraoxide nitrogen trioxide

Base Gas Family

Representative Test Agent = ammonia

allyl amine ammonia dimethyl hydrazine 1,2 methyl hydrazine

Hydride Family

Representative Test Agent = phosphine

Arsine germane phosphine stibine

Formaldehyde Family

Representative Test Agent = formaldehyde

formaldehyde

Particulate Family

Representative Test Agent = Dioctyl Phalthate (DOP)

adamsite sodium azide sodium fluoroacetate

Biological Particulates

Anthrax Brucellosis Glanders
Pneumonic Plague

Tularemia Q Fever Smallpox
Botulism

Ricin T-2 Mycotoxins Viral Hemorrhagic Fevers

Staphylococcus Enterotoxin B Venezuelan Equine
Encephalitis

Radiological/Nuclear Particulates

Hygrogen 3 Carbon 14 Phosphorouss 32 Cobalt
60

Nickel 63 Strontium 90 Technetium 99m Iodine
131

General Category Air Purifying Escape Respirators Gas/vapor Test Challenge Concentrations

Representative Test Agent	Test Challenge(ppm)	Breakthrough (ppm)
Ammonia	1250	25
Cyanogen Chloride	150	2
Cyclohexane	1300	10
Formaldehyde	250	10
Hydrogen Cyanide (C_2N_2)	470	10 (Sum of HCN and C_2N_2)
Hydrogen Sulfide	500	30
Nitrogen Dioxide	100	1 ppm NO_2
Phosgene	125	1.25
Phosphine	150	0.5
Sulfur Dioxide	750	5

Specific Category Air Purifying Escape Respirators

Are tested and approved for escape from low concentrations of chemical warfare agents and toxic industrial materials.

Plus tested against the specific hazard(s) at the concentrations listed below:

Category Gas/Vapor Test Challenge Concentrations

Representative Test Agent	Test Challenge(ppm)	Breakthrough (ppm)
Ammonia	2500	25
Cyanogen Chloride	300	2
Cyclohexane	2600	10
Formaldehyde	500	10
Hydrogen Cyanide	940	10 (Sum of HCN and C_2N_2)
Hydrogen Sulfide	1000	30
Nitrogen Dioxide	200	1 ppm NO_2
Phosgene	250	1.25
Phosphine	300	0.5

RDECOM Laboratory Respirator Protection Level (LRPL)

Face-fitting characteristics are determined by RDECOM by performing laboratory protection level

Probed respirators are quantitatively fit tested in a corn oil chamber using light scattering laser photometry.

Each test subject performs the following eleven exercises for one-minute each (8 OSHA standard exercises plus 3 additional first responder exercises*):

Normal Breathing

Deep Breathing

Turn Head Side to Side

Move Head Up and Down

Recite the Rainbow Passage

Grimace Exercise

Reach for the Floor and Ceiling

On Hands and Knees, Turn Head Side to Side*

Sight the Rifle*

Climb the stairs at regular pace*

Normal Breathing

CBRN air-purifying escape respirators must pass quantitative laboratory protection level testing with a minimum fit factor of 2,000.

Optional Carbon Monoxide Approval

In addition to CBRN agent approval, air-purifying escape only respirators are tested against 3600 ppm carbon monoxide and can receive service life ratings of either 15, 30, 45, or 60 minutes durations.

Flammability Testing

Air-purifying escape respirators submitted for approval for carbon monoxide protection shall be tested for Flammability and Heat Resistance using the test equipment specified in EN 136.

No component of the respirator shall have an after flame after 5 seconds.

No component of the escape respirator shall drip, melt, or develop a visible hole.

Additional Certification Testing For:

(a) rough handing, including tests for heat, cold, humidity, vibration, and dropping;

(b) fogging resistance;

(c) breathing resistance;

(d) carbon dioxide;

(e) 30 second don time; and

(f) visual acuity.

TRAINING

Manufacturer must provide instruction manual and training respirator that mimics the performance of the approved respirator, such as inhalation and exhalation breathing resistance.

Markings and Labels

Approval labels shall be marked with a CBRN Rating. For example:

General Category Air Purifying Escape Respirators approved for 30 minutes duration are marked:

ESCAPE ONLY NIOSH CBRN 30

Respirators receiving approval for a 30 minute duration rating with carbon monoxide protections are marked:

ESCAPE ONLY NIOSH CBRN 30 with Carbon Monoxide

Respirators receiving approval for a 30 minute duration rating with a specific category are marked:

ESCAPE ONLY NIOSH CBRN 30 with "chemical" Specific

CBRN Self-Contained Escape Respirator

Self-contained escape respirators are approved for the general population to escape from unknown conditions and oxygen deficiency.

Hoods will have either nose cups, mouthpiece with nose clip, or hood only.

Minimum service life of 15 minutes.

MUST PASS CHEMICAL AGENT PENETRATION AND PERMEATION TESTING AT RDECOM

Respirator is operated on the SMARTMAN in an enclosed in an air-tight exposure chamber.

10,000 mg/m^3 Sarin (GB) vapor challenge for the duration of the test (e.g., 30, 60, 90, or 120 minutes)

300 mg/m^3 Distilled Sulfur Mustard (HD) vapor for the duration of the test (e.g., 30, 60, 90, or 120 minutes)

0.50 milliliters liquid HD (applied

Additional Certification Testing For:

(a) rough handing, including tests for heat, cold, humidity, vibration, and dropping;

(b) fogging resistance;

(c) breathing resistance;

(d) carbon dioxide;

(e) 30 second don time; and

(f) visual acuity.

All CBRN Self-Contained Escape Respirator are tested for Flammability and Heat Resistance.

Laboratory Respirator Protection Level (LRPL)

The measured laboratory respiratory protection level (LRPL) for each CBRN self-contained escape respirator shall be 3000 or greater, for 95% of trials, sampled in the breathing zone of the respirator.

In addition, the LRPL must be at least 150 for 95% of trials sampled outside the breathing zone (under the hood).

TRAINING

Manufacturer must provide instruction manual and training respirator that mimics the performance of the approved respirator, such as inhalation and exhalation breathing resistance.

Pentagon Escape Respirator

In February 2003, Washington Headquarters Services and Pentagon Force Protection Agency purchased 80,000 escape hood respirators (Survivair Quick2000®) to protect Pentagon from terrorist threats.

Edgewood Chemical Biological Center (ECBC), at Aberdeen Proving Ground, Edgewood MD tested the Survivair Quick2000® per their in-house protocol for testing CBRN Escape Hoods.

Survivair had been working on its design with ECBC since 1998 under a Test Support Agreement. At the time, there was no NIOSH standard for certifying chemical-biological escape hoods.

Final Report, TESTING OF ESCAPE MASKS, Volume I, Quick2000 Escape Hood, for Technical Support Working Group Task 197B of Nov 02

Quick2000 was operated at 50 lpm on the SMARTMAN in an enclosed in an air-tight exposure chamber.

- 1,000 mg/m^3 Sarin (GB) vapor challenge for test duration,
- 500 mg/m^3 Distilled Sulfur Mustard (HD) vapor for test duration,
- 10 g/m^2 of HD liquid was applied to the HD liquid/vapor tests.

Corn oil chamber, quantitative fit testing indicated that the Quick2000® provides a **protection factor of at least 500** for 15 to 30 minutes.

Joint Service Chemical Environment Survivability Mask (JSCESM)

The JSCESM air-purifying hooded escape respirators provide above the neck protection against low level CBR attack, especially in “operations other than war.”

For protection against direct threat from CBR agents, standard Mission Oriented Protective Posture (MOPP) protective equipment (e.g. JSGPM, M40, MCU-2A/P, etc.) will be utilized.

The JSCESM will be light weight and designed to be compatible with warfightering equipment, such as communications systems, optical displays, and sighting systems. The masks will be one-size-fits-all, adult only, inexpensive and disposable.

Need for JSCSEM is Based on Shortcomings of Existing Masks

Current masks are:

- Not one-size-fits-all,
- Are not disposable,
- Cannot be stowed in a cargo pocket of common military duty uniforms,
- Add both weight and physiological burdens to the operator,
- Restrict field-of-view;
- Impair communications;
- Lack compatibility with common service equipment
- Increased breathing resistance contribute to

JSCESM Block I and Block II

Block I JSCESM will be a Commercial-Off-the-Shelf (COTS) mask procurement item with possible minor modifications that is readily available on the commercial market. The mask will provide low-level threat emergency escape protection for combatant and non-combatant operations and emergency evacuations.

Examples of use include, operators in other than warfare roles such as emergency evacuation and first responder personnel.

The Block II JSCESM will be a modified COTS product, which will provide enhanced capabilities necessary to meet specific warfighter requirements including for combatant and non-combat operations when the standard issue in-service mask is either

Performance Matrix

Threshold [T] - Objective [O]

Parameter	Block I	Block II
ISCESM Protection	Provide 2 hour [T] to 6 hour [O] service life for CBR agents	Provide 6 hour [T] to 8 hour [O] service life against CBR agents & TICs & TICs
Protection Factor	Greater than 1,000	Greater than 1,000
Drinking current Capability	N/A	Capable of interfacing with drinking systems intake > 200ml/min with no loss of protection
Wearability	One size fits all Inhalation <70 mm H_2O at 85 lpm Exhalation <20 mm H_2O at 85 lpm	One size fits all Inhalation <45 mm H_2O at 85 lpm Exhalation <20 mm H_2O at 85 lpm

Performance Matrix

Objective [O] - Threshold [T]

Parameter	Block I	Block II
Donning	< 45 seconds	< 45 seconds
Weight packaging	Less than 2lb. with packaging	Less than 2lb. with packaging
Compatibility	N/A	JSCESM is no larger than 50 cubic inches. Will fit in common service uniforms.
Vision	Permit unobstructed forward vision.	Permit unobstructed forward vision capabilities needed to complete military missions.
Speech	Permit intelligible voice	Permit use of military

NIOSH APPROVAL OF JSCESM

The Operational Requirement Document states that NIOSH certification will be sought, but lack of such certification will not preclude use of the JSCESM during military operations.

ANY QUESTIONS ?